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August 18, 2005

MS APPEAL BRIEF-PATENTS
COMMISSIONER FOR PATENTS
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Attn: Board of Patent Appeals and Interferences

Re: Patent Application of Hitomi SAKURAI
Serial No. 10/616,732
Filed: July 10, 2003
Group Art Unit - 2812
Examiner: Alexander G. Ghyka
Docket No. S004-5072

S I R:

Appellant submits herewith, in triplicate, their brief on appeal in connection with the captioned application. A check in the amount $500.00 is enclosed herewith to cover the required appeal fee. Should the check prove insufficient for any reason, authorization is hereby given to charge any deficiency to Deposit Account No. 01-0268.

Respectfully submitted,

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BLA:db
Enclosures

MAILING CERTIFICATE

I hereby certify that this correspondence is being deposited with the United States Postal Service as first-class mail in an envelope addressed to: MS APPEAL BRIEF-PATENTS, COMMISSIONER FOR PATENTS, P.O. Box 1450, Alexandria, VA 22313-1450, on the date indicated below.

Debra Buonincontri
Name

Debra Buonincontri
Signature

August 18, 2005
Date

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

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Application of	:	
Hitomi SAKURAI	:	
Serial No. 10/616,732	:	Group Art Unit: 2812
Filed: July 10, 2003	:	Examiner: Alexander G. Ghyka
For: METHOD FOR MANUFACTURING A SEMICONDUCTOR DEVICE (As Amended)	:	Docket No. S004-5072

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APPEAL BRIEF UNDER 37 C.F.R §41.37

MS APPEAL BRIEF-PATENTS
COMMISSIONER FOR PATENTS
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S I R:

This is an appeal pursuant to 37 C.F.R. §134 from the Examiner's decision rejecting claims 1-4 and 15-20 as set forth in the final Office Action of April 6, 2005.

I. Real party in interest.

The real party in interest in this appeal is Seiko Instruments Inc., assignee of the inventor's entire interest.

II. Related appeals and interferences.

None.

III. Status of claims.

Claims 1-4 and 15-20 stand finally rejected and are the subject of this appeal.

IV. Status of amendments.

In response to the April 6, 2005 final Office Action, an amendment after final was filed July 6, 2005 presenting arguments traversing the prior art rejections under 35 U.S.C. §103(a). In an Advisory Action dated August 5, 2005, 2005, the Examiner indicated that the arguments presented in the amendment after final do not overcome the rejections under 35 U.S.C. §§102(e), 103(a) set forth in the final Office Action, and that the rejections of the claims would remain as stated in the final Office Action.

V. Summary of claimed subject matter.

The present invention is directed to a method for manufacturing a semiconductor device, such as a MOS transistor.

Figs. 2A-2E show a conventional method for manufacturing a semiconductor device. As described in the specification (pgs. 1-3), a first oxide film 11 is formed on a surface of a silicon substrate 9 (Fig. 2A) and is then subjected to a nitriding treatment (Fig. 2B). As a result of the nitriding treatment, silicon oxynitride 12 is formed at an interface between the surface of the silicon substrate 9 and

the first oxide film 11. The first oxide film 11 is then removed from a portion of the surface of the silicon substrate 9 using a hydrofluoric acid (Fig. 2C) for the purpose of preparing the portion of the surface of the silicon substrate so that a second oxide film 14 can be formed thereon (Fig. 2D).

However, the use of the hydrofluoric acid alone has been insufficient to completely remove the silicon oxynitride 12 formed at the interface between the portion of the surface of the silicon substrate 9 and the first oxide film 11. As a result, the silicon oxynitride 12 remains on the portion of the surface of the silicon substrate 9 from which the first oxide film 11 has been removed (see Fig. 2C). The remaining silicon oxynitride 12 acts as an inhibitor against oxidation during formation of the second oxide film 14 which is formed by thermal oxidation, thereby affecting the reliability of the second oxide film 14 (specification, pg. 2, line 8 to pg. 3, line 4).

The present invention overcomes the drawbacks of the conventional art. Figs. 1A-1E show and page 1, line 3 to page 5, line 23 describe an embodiment of a method for manufacturing a semiconductor device according to the present invention embodied in the claims. A first silicon oxide film 3 is first formed on a semiconductor substrate 1 (Fig. 1A). The first silicon oxide film is then subjected to a nitriding

treatment so that silicon oxynitride 4 forms at an interface between the semiconductor substrate 1 and the first silicon oxide film 3 (Fig. 1B). According to the present invention, the first silicon oxide film 3 is then completely removed from a portion of the semiconductor substrate 1 using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride 12 formed at the interface between the portion of the semiconductor substrate 1 and the first silicon oxide film 3 is also completely removed (Fig. 1C). A second silicon oxide film 6 is then formed on the portion of the semiconductor substrate 1 from which the first silicon oxide film 3 and the silicon oxynitride 12 have been completely removed (Fig. 1D).

By the foregoing manufacturing method according to the present invention, the silicon oxynitride which forms at the interface between the semiconductor substrate and the first silicon oxide film during the nitriding treatment is completely removed using the ammonia-hydrogen peroxide solution. As a result, deterioration of the second silicon oxide film, which is subsequently formed on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride are completely removed, is effectively prevented (specification, pg. 3, lines 10-17; pg. 6, line 20 to pg. 7, line 1).

VI. Grounds of rejection to be reviewed on appeal.

The grounds of rejection for review are:

(A) The rejection of claims 1 and 3 under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,235,590 to Daniel et al. ("Daniel"); and

(B) The rejection of claims 2, 4 and 15-20 under 35 U.S.C. §103(a) as being unpatentable over Daniel.

VII. Argument

(A) Rejection of claims 1 and 3 under 35 U.S.C. §102(e) as being anticipated by Daniel

i. Argument for independent claim 1

Independent claim 1 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film having a first thickness on a silicon substrate, nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film, removing the first silicon oxide film from a part of the silicon substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed, and forming a second silicon oxide film in at least a

portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness. No corresponding combination of steps is disclosed or described by Daniel.

Daniel discloses a method for manufacturing a semiconductor device having devices with gate insulating layers 16, 18 having different thicknesses (Figs. 2A-2G). Prior to forming the gate insulating layers 16, 18 on a surface 36 of a substrate 20, the surface 36 of the substrate 20 is cleaned using standard SC1 and SC2 techniques (col. 3, lines 23-30; Fig. 2A). Thereafter, a first silicon oxynitride layer 38 is formed on the surface 36 of the substrate 20 (Fig. 2B). A photoresist pattern 40 is then formed over the first silicon oxynitride layer 38 (Fig. 2C). After formation of the photoresist pattern 40, the first silicon oxynitride layer 38 is etched (Fig. 2D). As shown in Fig. 2E, the photoresist pattern 40 is stripped, causing the formation of a thin chemical oxide layer 42 on the surface 36 of the substrate 20 (Fig. 2E). The surface 36 of the substrate is then cleaned to remove the chemical oxide layer 42 using standard SC1 and SC2 techniques (Fig. 2F). Daniel discloses that only about 3-4 angstroms are removed from the remaining first oxynitride layer 38 during the substrate cleaning process in Fig. 2F

(col. 4, lines 15-18). A second silicon oxynitride layer 44 is then formed over the substrate (Fig. 2G), including over the first oxynitride layer 38 (col. 4, lines 19-26).

However, Daniel does not disclose or describe the combination of steps recited in independent claim 1. First, claim 1 requires the steps of forming a first silicon oxide film on the surface of a silicon substrate, completely removing the first silicon oxide film from a part of the surface of the silicon substrate, and forming a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film is removed. The Examiner contends that the elements denoted by reference numerals 36 and 44 in Daniel correspond to the first and second oxide films recited in claim 1. However, as set forth above, and contrary to the Examiner's contention, numeral 36 in Daniel denotes the surface of the substrate 20, and numeral 44 denotes an oxynitride layer. Daniel does not disclose or describe the complete removal of a first silicon oxide film from a part of the silicon substrate, and the formation of a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film is removed, as recited in claim 1.

Furthermore, claim 1 requires the formation of silicon oxynitride at an interface between the silicon substrate and the first silicon oxide film during a nitriding

step, and the subsequent complete removal of the silicon oxynitride using a chemical containing at least an ammonia-hydrogen peroxide solution. Daniel discloses the formation and subsequent etching of a first oxynitride layer 38. However, contrary to the Examiner's contention, the first oxynitride layer is not completely removed. More specifically, Daniel discloses that during the substrate surface cleaning process, "only about 3-4 angstroms (A) are removed from the remaining first oxynitride layer 38" (col. 4, lines 15-18). Furthermore, Daniel discloses that a second oxynitride layer 44 "is grown over ... the first oxynitride layer 38" (col. 4, lines 22-26), that is, the first oxynitride layer 38 is not completely removed because it is still present when the second oxynitride layer 44 is subsequently formed.

Moreover, Daniel discloses the use of a standard SC1 technique which involves the use of ammonia-hydrogen peroxide. However, in Daniel the standard SC1 technique is used to clean the surface 36 of the substrate to remove any residual oxide as well as surface contaminants (col. 3, lines 24-30), and later to clean the surface of the substrate 36 to remove the chemical oxide layer 42 (col. 4, lines 9-12). Daniel does not disclose or describe the use of ammonia-hydrogen peroxide for the purpose of removing silicon oxynitride formed at an interface between the silicon substrate and a first silicon oxide film, as recited in claim 1.

In addition, claim 1 requires the formation of first and second silicon oxide films having different thicknesses. The Examiner contends that the film 44 in Daniel corresponds to a second silicon oxide film which is formed (i.e., grown) with a thickness greater than a first silicon oxide film, citing column 4, lines 36-45 in Daniel in support of this contention. As set forth above, Daniel does not disclose or describe the first and second silicon oxide films recited in claim 1. Additionally, in column 4, lines 36-45, Daniel merely discloses that the rate of growth of the second oxynitride layer 44 on the bare silicon surface 36 tends to be greater than the rate of growth of the second oxynitride layer 44 on the first oxynitride layer 38. Stated otherwise, column 4, lines 36-45 of Daniel merely discloses that the thicknesses of the portions of the second oxynitride layer 44 (i.e., the same layer) on the bare silicon surface 36 and on the first oxynitride layer 38 are different. This disclosure clearly does not relate at all to the formation of independent silicon oxide layers having different thicknesses, as required by claim 1.

In the absence of the foregoing disclosure recited in independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art

reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found"); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Daniel for the reasons stated above. Furthermore, Daniel does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Daniel's manufacturing method to arrive at the claimed invention.

i. Argument for independent claim 3

Independent claim 3 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film having a first thickness on a silicon substrate, nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film, removing

the first silicon oxide film from a part of the silicon substrate, washing the part of the silicon substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed, and forming a second silicon gate oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness.

Thus, independent claim 3 requires the following steps which are not disclosed or suggested by Daniel for the same reasons set forth above for independent claim 1: (a) the complete removal of a first silicon oxide film from a part of the silicon substrate, and the formation of a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film is removed; (b) the formation of silicon oxynitride at an interface between the silicon substrate and the first silicon oxide film during a nitriding step, and the subsequent complete removal of the silicon oxynitride using a chemical containing at least an ammonia-hydrogen peroxide solution; (c) the use of ammonia-hydrogen peroxide for the purpose of removing silicon

oxynitride formed at an interface between the silicon substrate and a first silicon oxide film; and (d) the formation of first and second silicon oxide films having different thicknesses.

In addition to the foregoing steps which are not disclosed or suggested by Daniel as set forth above for independent claim 1, independent claim 3 is separately patentable from Daniel because it requires that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed by washing the part of the silicon substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution. No corresponding step, in combination with the foregoing steps recited in independent claim 3, is disclosed or suggested by Daniel.

(B) Rejection of claims 2, 4 and 15-20 under 35 U.S.C. §103(a) as being unpatentable over Daniel

i. Argument for independent claim 15

Independent claim 15 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film on a semiconductor substrate, subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas so that silicon

oxynitride forms at an interface between the semiconductor substrate and the first silicon oxide film, completely removing the first silicon oxide film and the corresponding silicon oxynitride from a portion of the semiconductor substrate, and forming a second silicon oxide film on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride have been completely removed.

Thus independent claim 15 requires the step of completely removing the first silicon oxide film and the corresponding silicon oxynitride from a portion of the semiconductor substrate. No corresponding step is disclosed or suggested by Daniel as set forth above for independent claim 1. For example, Daniel does not address at all the complete removal of silicon oxynitride formed at an interface between a semiconductor substrate and a first silicon oxide film.

In addition to the foregoing, independent claim 15 is separately patentable from independent claims 1 and 3 over Daniel. As recognized by the Examiner (final Office Action, section 8, line 4-5), Daniel does not teach the complete removal of silicon oxynitride which is formed as a result of subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas, as required by independent claim 15. The Examiner contends, however, that it would have

been obvious to one ordinarily skilled in the art at the time the invention was made to modify Daniel's semiconductor device manufacturing method by subjecting a first silicon oxide film to an atmosphere containing at least an ammonia gas so that silicon oxynitride forms at an interface between the semiconductor substrate and the first silicon oxide film. Appellant vigorously disagrees with the Examiner's contention.

In order to support a claim rejection based upon obviousness under 35 U.S.C. §103, the Examiner must provide an evidentiary basis establishing the obviousness of each modification. The Examiner may do this by citing a reference which directly establishes this obviousness, or the Examiner may otherwise set forth a line of reasoning consistent with and motivated by the cited art establishing that such modifications would have been obvious. Mere speculation or conclusory allegations are simply inadequate to meet this burden. There must be some teaching, reason, suggestion, or motivation found in the prior art references to make a combination which renders an invention obvious within the meaning of 35 U.S.C §103. See, e.g., Symbol Technologies, Inc. v. Opticon, Inc., 935 F.2d 982, 989, 18 USPQ2d 1885 (Fed. Cir. 1991).

In order to set forth a prima facie case of obviousness, the Examiner must not only demonstrate that this teaching exists in the prior art, but that it would teach all

limitations of the claim. This burden cannot be met by citing references that, even if combined, fail to teach explicitly recited limitations.

In the instant case, the Examiner has not met his burden of establishing a prima facie case of obviousness as discussed above.

As noted by the Court of Appeals for the Federal Circuit in the case of In re Fritch, 23 USPQ2d 1780, 1783 (Fed. Cir. 1992):

> 'Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under section 103, teachings of references can be combined only if there is some suggestion or incentive to do so.' Although couched in terms of combining teachings found in the prior art, the same inquiry must be carried out in the context of a purported obvious 'modification' of the prior art. The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification. Wilson and Hendrix fail to suggest any motivation for, or desirability of, the changes espoused by the Examiner and endorsed by the Board.
>
> Here, the Examiner relied upon hindsight to arrive at the determination of obviousness. It is impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that '[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention.'

As further noted by the Federal Circuit in In re Oeticker, 24 USPQ2d 1443, 1444 (Fed. Cir. 1992):

> The prima facie case is a procedural tool of patent examination, allocating the burdens of going forward as between examiner and applicant. In re Spada, 911 F.2d 705, 707 n.3, 15 USPQ2d 1655, 1657 n.3 (Fed. Cir. 1990). The term 'prima facie case' refers only to the initial examination step. In re Piasecki, 745 F.2d1468, 1472, 223 USPQ 785, 788 (Fed. Cir. 1984); In re Rinehart, 531 F.2d 1048, 1052, 189 USPQ 143, 147 (CCPA 1976). As discussed in In re Piasecki, the examiner bears the initial burden, on review of the prior art or on any other ground, of presenting a prima facie case of unpatentability. If that burden is met, the burden of coming forward with evidence or argument shifts to the applicant.
>
> * * *
>
> If examination at the initial stage does not produce a prima facie case of unpatentability, then without more the applicant is entitled to grant of the patent. See In re Grabiak, 769, F.2d 729, 733, 226 USPQ 870, 873 (Fed. Cir. 1985); In re Rinehart, supra.
>
> In reviewing the examiner's decision on appeal, the Board must necessarily weigh all of the evidence and argument. An observation by the Board that the examiner made a prima facie case is not improper, as long as the ultimate determination of patentability is make on the entire record. In re Piasecki, 745 F.2d at 1472, 223 USPQ at 788; In re Rinehart, 531 F.2d at 1052, 189 USPQ at 147.

The Federal Circuit has therefore made it clear that the prior art must show an incentive to modify its teachings in order to render a claim obvious. Without such an incentive, a prima facie case of obviousness cannot be made.

Similarly, as this Board stated in Ex Parte Clapp, 227 USPQ 972, 973 (BPAI 1985):

> To support the conclusion that the claimed combination is directed to obvious subject matter, either the references must expressly or impliedly expound the modifications urged by the examiner to have been obvious.

The same situation exists here. The Examiner has not provided an evidentiary basis establishing the obviousness of his proposed modification of Daniel. There is nothing in the reference to Daniel that would expressly or implicitly teach or suggest the step of subjecting a first silicon oxide film to an atmosphere containing at least an ammonia gas for the purpose of forming silicon oxynitride at an interface between a semiconductor substrate and the first silicon oxide film, as recited in independent claim 15, and, therefore, Daniel does not directly establish this obviousness. Furthermore, the Examiner has not set forth a line of reasoning consistent with and motivated by the cited art establishing that such modification would have been obvious.

Thus one of ordinary skill in the art would not have been led to modify Daniel in the manner proposed by the Examiner in the statement of rejection. The only basis for the modification urged by the Examiner in the rejection is appellants' own disclosure, and such hindsighted rejections are improper. See, for example, Diversitech Corp. v. Century Steps, Inc., 7 USPQ2d 1315, 1318 (Fed. Cir. 1988); In re

Geiger, 2 USPQ2d 1276, 1278 (Fed. Cir. 1987); Panduit Corp. v. Dennison Manufacturing Co., 227 USPQ 337, 343 (Fed. Cir. 1985); Interconnect Planning Corp. v. Feil, 227 USPQ 543, 551 (Fed. Cir. 1985).

ii. Argument for dependents claims 2, 4 and 16-20

Claims 2, 4 and 16-20 depend on and contain all of the limitations of independent claims 1, 3 and 15, respectively, and, therefore, distinguish from Daniel at least in the same manner as independent claims 1, 3 and 15.

Moreover, there are separate grounds for patentability of dependent claims 2, 4, 16 and 18.

Each of dependent claims 2 and 4 requires the additional limitation that the nitriding step further includes the step of using an inert gas containing at least an ammonia gas. No corresponding step is disclosed or suggested by Daniel as set forth above for independent claim 15.

Claim 16 includes the additional limitation that the removing step comprises a first step of completely removing the first silicon oxide film from the portion of the semiconductor substrate, and a second step of washing the portion of the semiconductor substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution to completely remove the silicon oxynitride formed at the

interface between the portion of the semiconductor substrate and the first silicon oxide film. No corresponding step is disclosed or suggested by the prior art of record as set forth above for independent claim 3.

Claim 18 includes the additional limitation that the removing step comprises the step of removing the first silicon oxide film from the portion of the semiconductor substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film is completely removed. No corresponding step is disclosed or suggested by the prior art of record as set forth above for independent claim 1.

In view of the foregoing, appellants respectfully submit that claims 1-4 and 15-20 patentably distinguish over the prior art record and, therefore, the rejections of these claims should be reversed.

Respectfully submitted,

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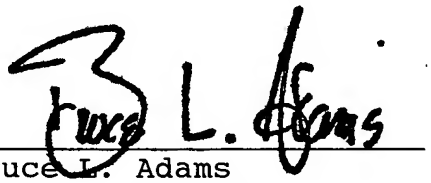
Attorneys for Appellant

By: 
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VIII. Claims appendix.

Appealed claims 1-4 and 15-20 are reproduced below in smooth form:

1. A method for manufacturing a semiconductor device, comprising the steps of:

forming a first silicon oxide film having a first thickness on a silicon substrate;

nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film;

removing the first silicon oxide film from a part of the silicon substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed; and

forming a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride have been removed, the second silicon oxide film having a second thickness different from the first thickness.

2. A method for manufacturing a semiconductor device according to claim 1; wherein the nitriding step includes the step of using an inert gas containing at least an ammonia gas.

3. A method for manufacturing a semiconductor device, comprising the steps of:

forming a first silicon oxide film having a first thickness on a silicon substrate;

nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film;

removing the first silicon oxide film from a part of the silicon substrate;

washing the part of the silicon substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed; and

forming a second silicon gate oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness.

4. A method for manufacturing a semiconductor device according to claim 3; wherein the nitriding step includes the step of using an inert gas containing at least an ammonia gas.

15. A method for manufacturing a semiconductor device, comprising the steps of:

forming a first silicon oxide film on a semiconductor substrate;

subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas so that silicon oxynitride forms at an interface between the semiconductor substrate and the first silicon oxide film;

completely removing the first silicon oxide film and the corresponding silicon oxynitride from a portion of the semiconductor substrate; and

forming a second silicon oxide film on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride have been completely removed.

16. A method for manufacturing a semiconductor device according to claim 15; wherein the removing step comprises a first step of completely removing the first silicon oxide film from the portion of the semiconductor substrate, and a second step of washing the portion of the

semiconductor substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution to completely remove the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film.

17. A method for manufacturing a semiconductor device according to claim 16; wherein the first step comprises the step of using an hydrofluoric acid to completely remove the first silicon oxide film from the portion of the semiconductor substrate.

18. A method for manufacturing a semiconductor device according to claim 15; wherein the removing step comprises the step of removing the first silicon oxide film from the portion of the semiconductor substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film is completely removed.

19. A method for manufacturing a semiconductor device according to claim 15; wherein the nitriding step includes the step of using an inert gas containing at least an ammonia gas.

20. A method for manufacturing a semiconductor device according to claim 15; wherein the semiconductor device comprises a MOS transistor; and wherein the first silicon oxide film comprises a gate oxide film of the MOS transistor.